

# Cross-Border Workshop Adaptation to Climate Change: Information and tools for Decision Making

## Climate Change and Soil Carbon

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# Soil organic matter is beneficial to agriculture through

- Physical properties
  - (e.g. soil structure, aggregation, porosity, moisture retention)
- Chemical properties
  - (e.g. ion exchange, buffering capacity, nutrient storage and release)

# Soil organic matter & agriculture

- Soils that are lacking in organic matter hold less water
  - This increase the likelihood of floods and the impact of droughts.

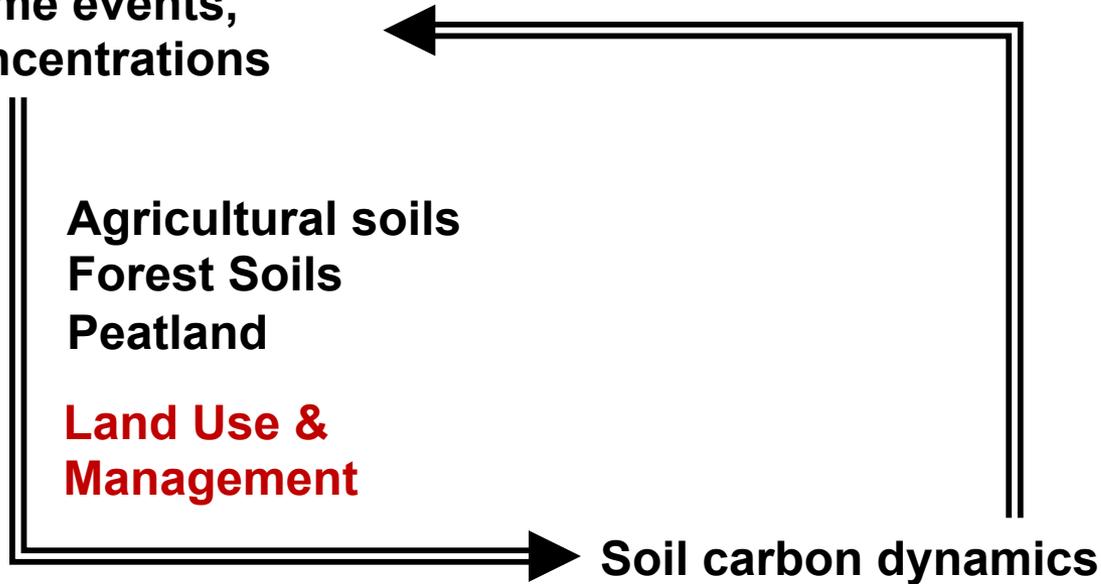
# Soil carbon feedback

Climate, extreme events,  
CO<sub>2</sub> & CH<sub>4</sub> concentrations

Agricultural soils  
Forest Soils  
Peatland

Land Use &  
Management

Soil carbon dynamics

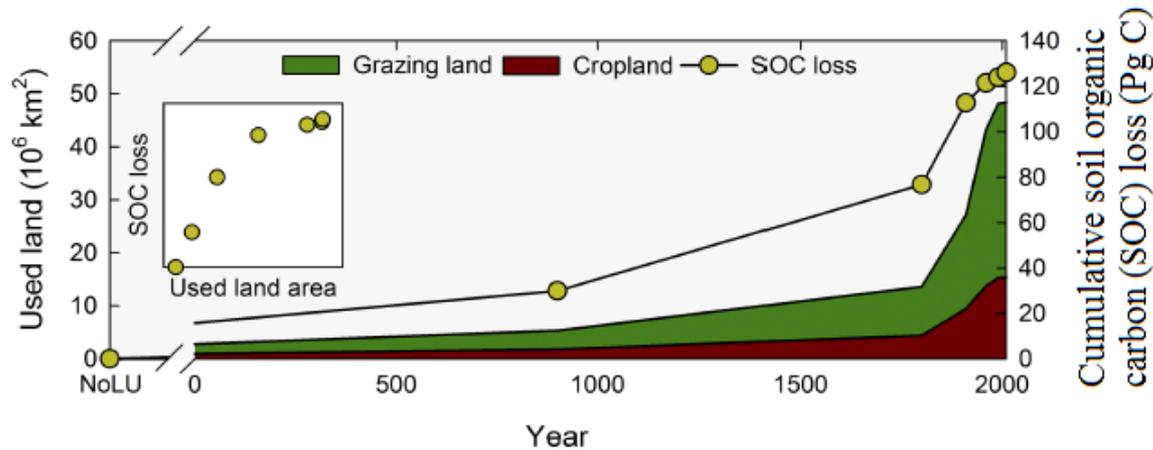


# Soil Carbon

2700 Gigatonnes of carbon, soils are the largest repository of organic carbon in the terrestrial biosphere.

By comparison, human activities currently release between 10-11 Gigatonnes of carbon annually into the atmosphere.

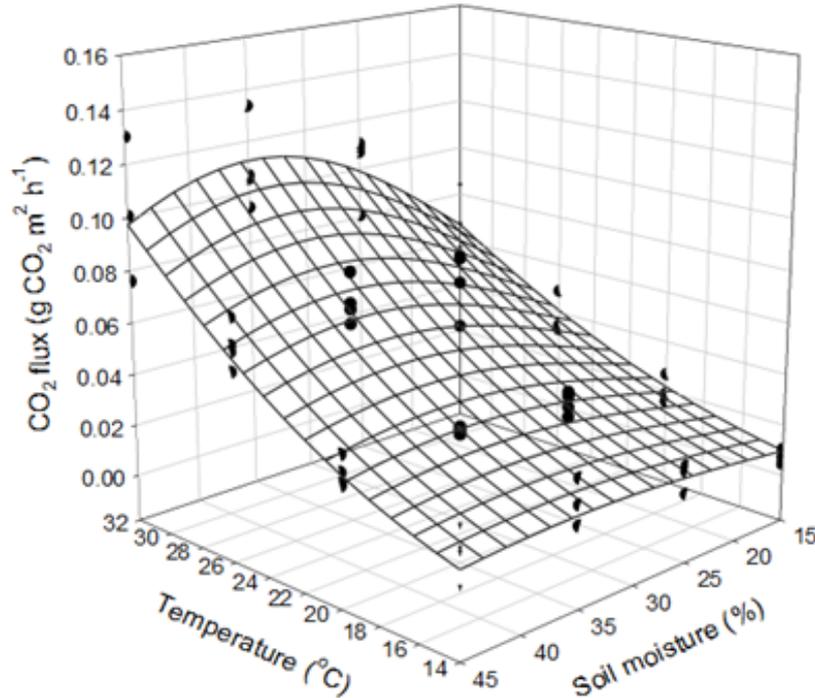
# Global soil carbon debt due to agriculture



Sanderman et al., 2017. PNAS, 114, 9575-9580.

- Approximately 42-133 Gigatonnes loss due to agriculture

# Soil carbon and warming



Short-term experiments show an important impact of temperature of soil organic matter mineralization

# C-content of agricultural soils sensitive to warming?

Davidson & Janssens, Extrapolation of decomposition rates a future warmer world based on observations of current apparent temperature sensitivities is inadequate. *Nature* 440, 165-173.

Giardina, & Ryan, Evidence that decomposition rates of organic carbon in mineral soil do not vary with temperature. *Nature*, 404, 858-861.

Fang, Smith, Moncrieff, & Smith. Similar response of labile and resistant soil organic matter pools to changes in temperature. *Nature*, 433, 57-59.

Knorr, Prentice, House, & Holland. Long-term sensitivity of soil carbon turnover to warming. *Nature*, 433, 298-301.

# Soil Organic Matter genesis

Carbon is the main component of soil organic matter

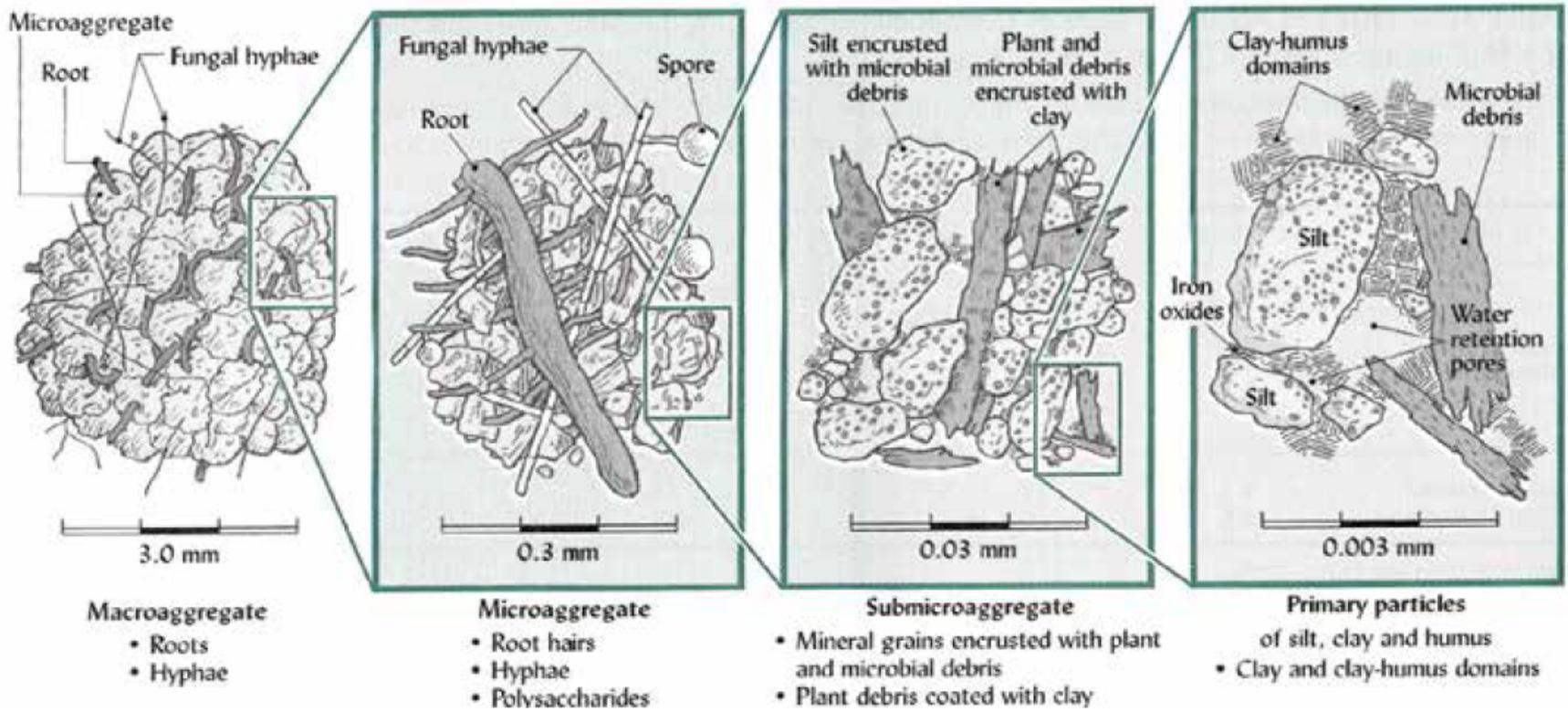
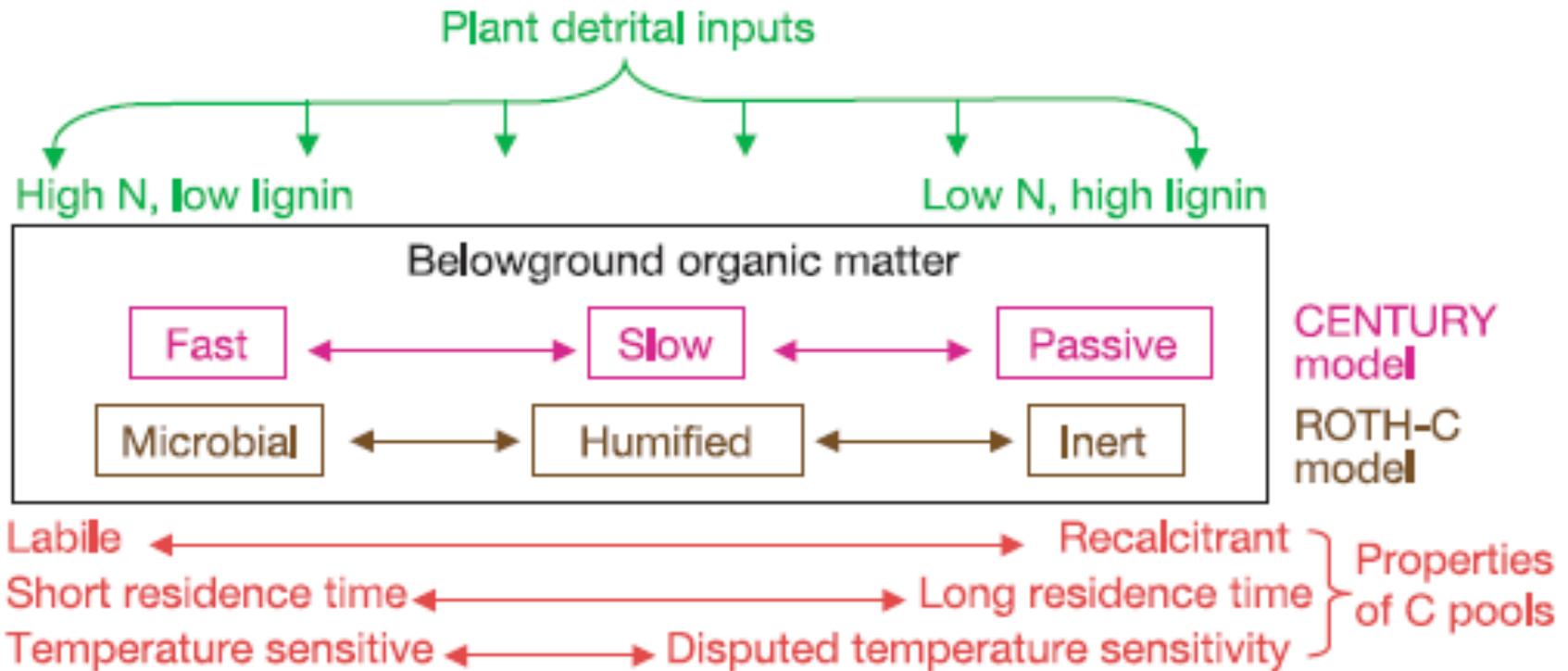


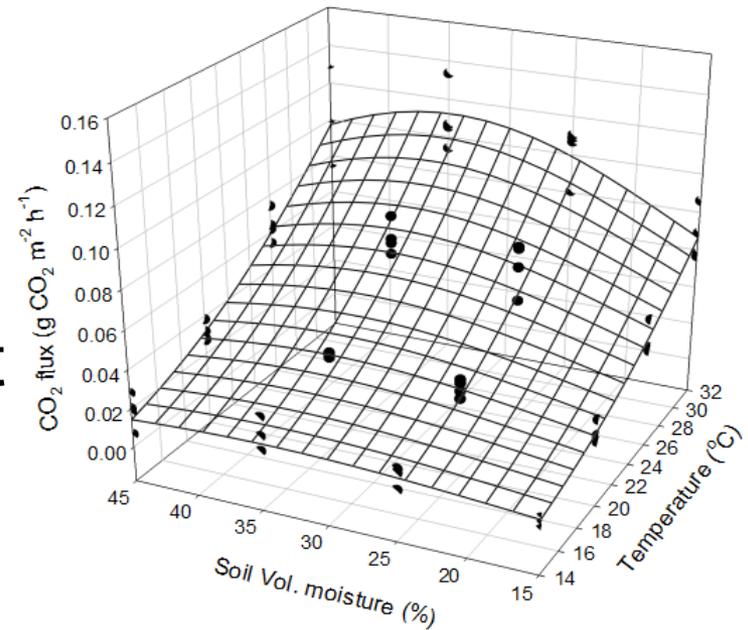
Image from: The Cornell Framework Manual on Assessment of Soil Health

# Soil Organic Matter fractions



# Droughts and dry climate cause a decrease in soil organic matter

- Due to organic molecules no longer protected in water saturated area of aggregates
- Microorganisms can decompose organic matter at low moisture level where plants cannot survive; creating a negative balance.



# Adaptation to Climate Change

- Improved Soil Management as Beneficial Management Practices (or conservation agriculture facets)

# Large carbon sequestration in some agricultural soils



# Avoiding excessive tillage and soil compaction

Tillage can break up soil structure, speed-up decomposition of organic matter, increase the threat of erosion, and cause compaction.



# Keeping the ground covered

Bare soil is susceptible to wind and water erosion, and to drying and crusting.

Living cover crops create new organic matter.



# Adding amendment

Additions of carbon or clay material is a noteworthy way to increase soil organic matter.

Example: residue from the previous crop, animal manure, biochar or other amendments from off the farm.



# Increasing diversity

Each crop contributes a unique root structure and type of residue to the soil. Diversity across the landscape can be increased by using buffer strips, small fields, or contour strip cropping. Diversity over time can be increased by adding crops to the crop rotation.



# Shelterbelts

Shelterbelts can be beneficial to reduce wind erosion



# Conclusion

We cannot accurately predict global warming effects on soil carbon in croplands. New knowledge on thermal response of decomposition of soil organic fractions is required.

Yet, we know several beneficial management practices that can increase soil carbon levels

- Thanks



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